

## THREE SPECIES OF *LINGULA* FROM THE QUEENSLAND COAST

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### ABSTRACT

On the basis of new taxonomic characters, *Lingula* species common on the Queensland coast are shown to belong to three species: *L. anatina*, *L. rostrum*, and *L. adamsi*. All three are described and illustrated on the basis of these new characters. The understanding of the taxonomy of the genus has been advanced in the present work. *L. bancrofti* is shown to be a synonym of *L. rostrum*, and *L. murphiana* of *L. anatina*. Collections studied are principally located in the Queensland Museum and these have been compared with material in the British Museum, the Museum National d'Histoire Naturelle de Paris, and the Australian Museum.

Johnston and Hirschfeld (1920) recognized the following species of the genus *Lingula* on the Queensland coast: *L. anatina* Lamarck > *L. rostrum* (Shaw); *L. tumidula* Reeve; *L. hians* Swainson > *L. hirundo* Reeve; *L. murphiana* Reeve; *L. exusta* Reeve; *L. bancrofti* Johnston and Hirschfeld. These species were all distinguished on the basis of the valve characters. However these show such a high degree of variability that they are unreliable as taxonomic criteria. Hedley (1909) considered that all Australian specimens should be assigned to a single species, although in 1916 he recognized the possibility that they represented more than one species. Recently, Hammond and Kenchington (1977), using morphometric characters, assigned the Queensland *Lingula* to only two species, *L. anatina* and *L. tumidula*.

As the *Lingula* species are not easy to distinguish from one another, they are often misidentified and confused. Queensland is the type locality for several of the species that have been designated in the genus. The present study was undertaken in an attempt to resolve some of the problems.

The taxonomic characters that are available on which to base taxonomy of the genus are reviewed and the Queensland specimens are redescribed.

### TAXONOMIC CRITERIA

The most commonly used features are on the shell (i.e. colour, convexity, calcification, opacity, general form, ratio length to breadth). They vary throughout the life of each individual, between

different populations, and within a population of the same species. The peduncle also varies in length owing to its capacity to regenerate, as well as its degree of contraction, and the amount of shrinking during fixation. All these criteria have been assigned some taxonomic value (Chuang 1962, Emig 1977c, Hammond and Kenchington 1977).

The shell ratios proposed by Chuang (1962) must be considered cautiously. The width/length ratio of the protogulum may be helpful in identification of juvenile specimens, but has been tested in only 3 species (Emig 1977c). The width/length ratio of the dorsal larval valve shows too great a variability (Emig 1977c). The width/length ratio of the whole shell, studied by Hammond and Kenchington (1977) cannot be used, since different species identified according to the two new criteria (set out below) have a similar w/l ratio. It appears, therefore, that all morphometric characteristics previously used to designate species must now be considered as inadequate for taxonomic purposes.

The validity of the morphology of deltidial regions and the arrangement of musculature, as distinguishing characters, has been demonstrated recently by Emig (1977a, 1977c). These two major features are used in this work to distinguish the Queensland species of *Lingula*. A third characteristic appears to be the disposition of the two main mantle canals. Information on the other non-taxonomic characters is also given.

*Lingula anatina* Lamarck

- Lingula anatina* Lamarck, 1801, p. 141. Davidson, 1888, p. 206. Emig, 1977b, p. 102.  
*Patella unguis* Linnaeus, 1758, p. 783.  
*Lingula unguis*: Rowell, 1964, p. 223.  
*Lingula murphiana* Reeve, 1859, pl. 1. Davidson, 1888, p. 215. Johnston and Hirschfeld, 1920, p. 58. Emig, 1977a, p. 402.  
*Lingula lepidula* Adams, 1863, p. 101. Davidson, 1888, p. 220. Hatai, 1940, p. 179.  
*Lingula smaragdina* Adams, 1863, p. 101. Davidson, 1888, p. 220. Hatai, 1940, p. 179.  
 ?*Lingula nipponica* Hayasaka, 1931, p. 364. Hatai, 1940, p. 181.  
 ?*Lingula hirundo* Reeve, 1859, pl. 2. Davidson, 1888, p. 220. Johnston and Hirschfeld, 1920, p. 53.

## MATERIAL EXAMINED

Moreton Bay: G5483 (Toorbul Point); G5207 (Sandgate); G2126 (Sandgate); G1084 (Wellington Point); G5118 (Dunwich); G11668 (Amity Point); G2305, 2306 (Nudgee Beach); G2100 (Traviston) (Queensland Museum). Southport: G2304, G12058-60,

G2872 (Queensland Museum). Burnett Heads: G5373, part G5487/1 (one specimen of 3 paratypes of *L. bancrofti*) (Queensland Museum). Northeast Queensland: G2283-5 (Proserpine); G11666 (Cardwell) (Queensland Museum). Port Curtis: AM C59917, C107138 (dried valves) (Australian Museum). Singapore, Senegal: material listed as *L. anatina* by Emig 1977a, b. Madagascar: material listed as *L. murphiana* by Emig 1977a.

All the Queensland Museum specimens previously assigned to *L. bancrofti* and *L. murphiana* have been compared with *L. anatina* (see above). No significant differences could be found between most specimens. The syntypes of *L. bancrofti* (AM C43925) are unquestionably synonymous with *Lingula rostrum*. However, of the three paratypes of *L. bancrofti* (QM G5487), two are assigned to *L. rostrum* and one to *L. anatina*. Johnston and Hirschfeld (1920) considered *L. rostrum* as a synonym of *L. anatina* while they regarded *L. bancrofti* as closely related to *L. anatina*. This confused later workers, and most of the specimens that were subsequently

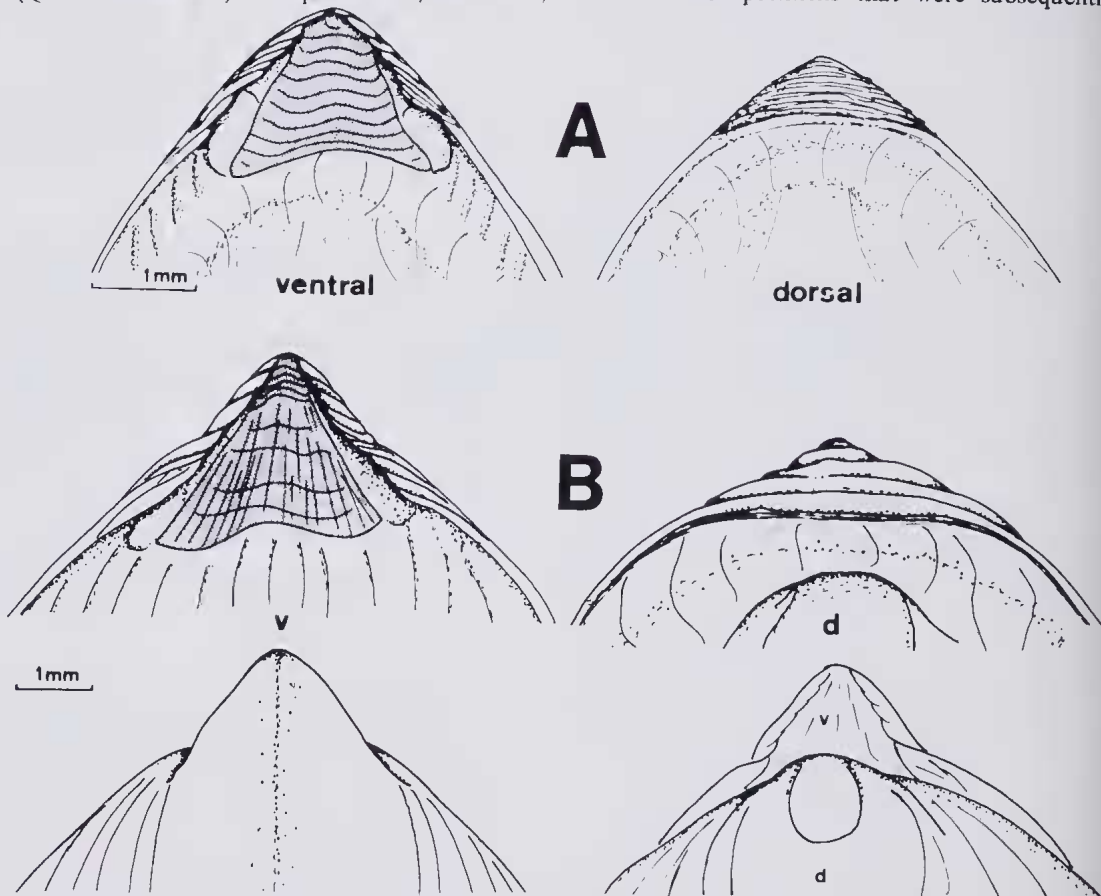


FIG. 1: Deltidial regions of A, *Lingula anatina* (interior view); B, *L. rostrum* (interior and exterior views).

assigned to *L. bancrofti* actually belong to *L. anatina*.

On the other hand, *L. murphiana* Reeve (type-locality: Moreton Bay) is without doubt a synonym of *L. anatina*. In his original description Reeve (1859) states 'this (*L. murphiana*) should be regarded as an Australian form of *L. anatina* or as a distinct species, it is certain that the differences are obvious and constant'. The first assertion is confirmed. Johnston and Hirschfeld (1920, p. 58) correctly named Australian specimens *L. anatina*, and so did Hedley (1909) whose dried valves (AM C59917 and C107138) were examined and his identification confirmed.

The characteristics of *L. anatina* from Queensland waters are as following:

The shell is oblong-elongate, has parallel lateral margins, sometimes slightly concave in large specimens. The anterior edge is nearly straight, or slightly convex, with a median angular projection; frontal margins are almost equal (Plate 1a). The deltidial region of the ventral valve possesses a longer beak than the dorsal one and, on the inner surface, a shallow pedicular groove. The beak of the dorsal valve has a somewhat flattened inner face (Fig. 1A, Plate 1a, c).

The external surface of the shell valves is rather smooth, but growth lines are distinct (Plate 1a, b). Three low-siphonal ribs extend from beak to the anterior margin of the shell in the direction of the three clusters of setae (Plate 1a, d). Internally, the surface is smooth. The dorsal valve shows a well-marked median ridge (Plate 1c) that is only outlined on the ventral valve. The degree and extent of calcification is variable, as is the colour, which is generally greenish to dark-greenish.

In side view, the shell of *L. anatina* is slightly elliptical (Plate 1b).

The peduncle, fleshy in colour, is once to twice the length of the shell. No pallial pigmentation is observed. The arrangement of musculature (Fig. 2A) is comparable in all points with previous data (Emig 1977a, 1977b). Measurements of dorsal larval valve are similar to those given by Chuang (1962): width 574–651  $\mu$ ; length 667–853  $\mu$ . The ratio w/l is 0.763–0.897. The two main mantle canals are generally elongate and only a little incurved (Fig. 2A).

*L. lepidula* Adams and *L. smaragdina* Adams are generally considered as juvenile forms of *L. anatina* (Davidson 1888, Hatai 1940). Hatai (1940) believed that *L. nipponica* probably also belonged to *L. anatina* from which it is distinguished only by the outline of the shell. Hatai's description however could also agree with *L. rostrum*. *L. hirundo* Reeve (type locality Port

Curtis) is another possible synonym of *L. anatina*, as some dried valves from Port Curtis (Australian Museum collection) suggest a close resemblance with *L. anatina*. This view is supported by Johnston and Hirschfeld (1920) who point out that the form and the proportion (of *L. hirundo*) do not agree with *L. bancrofti* (< *L. rostrum*).

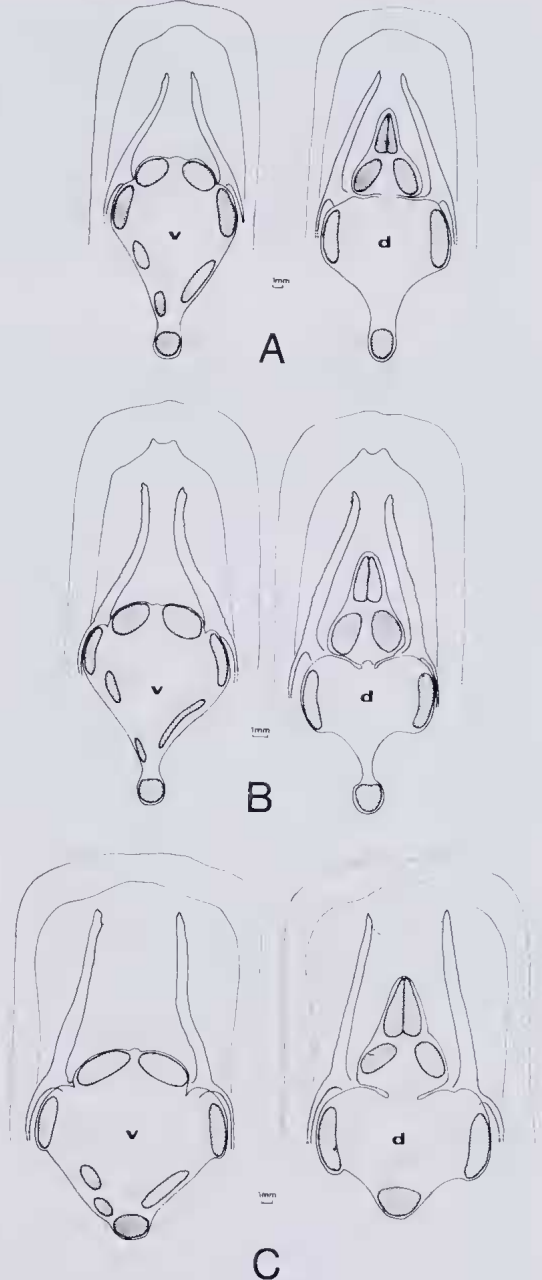


FIG. 2: *Lingula rostrum*: arrangement of the musculature and disposition of the two main anterior mantle canals of A, *Lingula anatina*; B, *L. rostrum*; C, *L. adamsi*.



The view of Hammond and Kenchington (1977) that *L. bancrofti*, *L. exusta*, *L. hians*, *L. murphiana* should all be assigned to the type species *L. anatina* is not supported by the present observations.

### *Lingula rostrum* (Shaw)

*Mytilus rostrum* Shaw, 1797, pl. 315.

*Lingula hians* Swainson, 1823, p. 401. Sowerby, 1846, p. 338. Davidson, 1888, p. 216. Johnston and Hirschfeld, 1920, p. 54.

*Lingula exusta* Reeve, 1859, pl. 2. Davidson, 1888, p. 217. Johnston and Hirschfeld, 1920, p. 63.

*Lingula bancrofti* Johnston and Hirschfeld, 1920, p. 67.

?*Lingula affinis* Hancock, 1858, p. 791. Davidson, 1888, p. 215.

#### MATERIAL EXAMINED

Burnett Heads: G5487/2, 3 (2 specimens of 3 paratypes of *L. bancrofti*) (Queensland Museum); AM C43925 (syntypes of *L. bancrofti*) (Australian Museum). Moreton Bay: G5298 (Redland Bay); G984, G1056 (Sandgate) (Queensland Museum). Port Denison: AM C43684 (Australian Museum). Dunk Island: G11667 (Queensland Museum); AM C45047 (Australian Museum). Amboina (type-locality): material listed as *L. rostrum* by Cals and Emig 1979.

A comparison of *L. rostrum* from Amboina (type-locality) with the Queensland material, indicates that many individuals belong to *L. rostrum*, but that some specimens have been wrongly assigned to that species. Examinations of the syntypes and paratypes of *L. bancrofti* indicate that it is undoubtedly a synonym of *L. rostrum*. However Johnston and Hirschfeld (1920) were wrong in designating *L. rostrum* as a synonym of *L. anatina*. *Lingula hians* and *L. exusta* are also synonyms of *L. rostrum*. *Lingula hians*: Johnston and Hirschfeld (1920) was described from dried valves, rather distorted. Several specimens from the Australian Museum collection were previously referred either to *L. hians* or *L. exusta*, but they could not be distinguished in any way from *L. rostrum*. *Lingula exusta*, from its type-locality, Moreton Bay, closely resembles *L. rostrum* from its type-locality (see also Sowerby, 1846, and Davidson, 1888). Further, Reeve (1859) adds 'If *L. murphiana* is an Australian form of *L. anatina*, this (*L. exusta*) might be regarded as the representative in the same locality of *L. hians*'. Specimens from Dunk Island have been determined by Johnston and Hirschfeld (1920) as *L. exusta*, but several individuals occurring in this locality (QM G11667; AM C45047) are referred

to *L. rostrum*. Under the name *L. affinis*, Hancock (1858) describes and figures a species agreeing either with *L. rostrum* or *L. reevii*, while his other species has been correctly identified as *L. anatina*.

The characteristics of *L. rostrum* from the Queensland waters are described below:

The shell is oblong-ovate. The lateral margins are subparallel, often broadest posteriorly, rarely anteriorly. The anterior front is slightly convex with a small median projection; the frontal angles are rounded. The anterior edges are almost superposed (Plate 1e). *Lingula rostrum* is characterized by the possession of a posterior 'rostrum' (= deltidial beak of ventral valve), largely projecting over the dorsal valve and distinct from the continuity of posterior margins, that is visible on the external face (Fig. 1B, Plate 1f). The pedicular groove is deep and almost continuous with the inner surface of the valve (Fig. 1B), as in *Lingula reevi*.

The external surface of the shell is rather smooth with visible lines of growth (Plate 1e, f). The inner surface is smooth and only the dorsal valve shows a short internal median ridge. The degree of calcification is variable. The shell colour varies from yellow to reddish beige with some vivid green lines of growth. Generally the front is bright green. In transverse section, the shell of *L. rostrum* is elliptical, slightly flattened (Plate 1f).

The peduncle, brownish in colour is about one and a half the length of shell. No strong pallial pigmentation is observed. The muscle arrangement is shown in Fig. 2B; it is somewhat different from that of *L. anatina*, but very similar to *L. reevii* (Emig 1978). The two main mantle canals are more incurved to the middle than in *L. anatina* (Fig. 2B). Measurement of the dorsal larval valve has been performed on three specimens: width 654–711  $\mu$ ; length 842–887  $\mu$ . The mean w/l ratio is 0.804.

### *Lingula adamsi* Dall

*Lingula tumidula*: Adams, 1863, p. 100. Davidson, 1871, p. 310. (non *L. tumidula* Reeve 1841).

*Lingula adamsi* Dall, 1873, p. 202. Davidson, 1888, p. 218.

*Lingula shantungensis* Hatai, 1937, p. 322; Hatai, 1940, p. 177.

#### MATERIAL EXAMINED

Moreton Bay: G5659. Yeppoon: QM G5486 (Queensland Museum); AM C2476 (Australian Museum). Queens Beach, Bowen: QM G5879 (Queensland Museum). Formosa: B12561 (figured by Davidson 1888, pl. 28, fig. 19) (British Museum).

A careful comparison of a single specimen in the Museum National d'Histoire Naturelle de Paris with the descriptions of Reeve (1841, 1859), Sowerby (1846), Dall (1873), and Davidson (1888), and the Queensland specimens, has indicated that *L. tumidula* Reeve and *L. adamsi* Dall are two distinct species. This is corroborated by the examination of the probable holotypes of these two species, deposited in the British Museum (*L. adamsi*: B12561, Formosa; *L. tumidula*: ZB 338-340, Moreton Bay). Thus the assertion of Dall (1873) that *L. adamsi* is distinct from *L. tumidula*, that was accepted by Davidson (1888), is confirmed. The single specimen of MNHN-Paris could be referred without hesitation to *L. tumidula*. It is very similar to the holotype and true to the original description of Reeve (1841), and the accounts of Sowerby (1846) and Davidson (1888). On the other hand, all examined specimens with a large quadrate shell in the Queensland Museum are identical with *L. adamsi* holotype and original description, rather than with *L. tumidula* (despite the fact that Australian specimens have generally been referred to the latter species). This confusion has arisen because *L. tumidula* type-locality is Moreton Bay, accordingly all quadrate shell individuals on the Queensland coasts have been assigned to that species rather than to *L. adamsi*. Davidson (1888) indicates that he fell at first into the same mistake.

The Queensland Museum material contains only *L. adamsi* which has the following characteristics:

The Australian specimens are characterized by the possession of a very large shell, quadrate in outline. The anterior edge is straight to gently concave without a projection in the middle; its lateral corners squarely rounded. The lateral margins are subparallel (Plate 2). The deltidial regions are very different from those of the other lingulid species. The deltidium of the dorsal valve shows a rounded margin, with ill-defined beak; the ventral valve possesses a small, sharply, median beak, slightly overlapping the dorsal valve, and a small groove, on the inner surface, for the pedicle passage (Plate 2e).

The external surface of the shell is marked with several rude equidistant growth lines (that become more distinct as the shell grows: Plate 2) and numerous small concentric lines of growth. The shell sculpture looks and feels rough. Two longitudinal ridges extend from the highest point of the valve to each frontal corner, especially on the ventral valve. In lateral view, the dorsal valve becomes more flattened than the ventral. The colour is yellowish brown to dark brown with

reddish brown to darkest brown distally. The pedicle, flesh in colour, is almost twice as long as the shell. No pallial pigmentation has been observed. The setae of the frontal angles are conspicuously long (Plate 2c). The muscle attachment is not visible through the shell; its arrangement is different from that of the other lingulids that have the same quadrate body shape (Plate 2 b, e). The two main mantle canals are subparallel anteriorly (Plate 2b, e).

The characteristics of *L. shantungensis* described by Hatai (1937, 1940) seem to be similar to those of *L. adamsi*, and these species are probably synonymous. A comparative study on *L. tumidula* and *L. adamsi* is now in preparation by C. C. Emig and L. Hammond.

#### CONCLUSIONS

In the present study the distribution of *Lingula* species in Queensland waters has been largely modified according to new specific criteria (one of the characters, disposition of the two anterior mantle canals has been used for the first time). The examination of species types and specimens from the type-localities has demonstrated that *L. anatina*, *L. rostrum* and *L. adamsi* are the most commonly occurring Queensland species. Several synonymies have been established and the species are considered to be true taxa in the studied geographical area. *Lingula murchiana* is now referred to *L. anatina*. *Lingula hians*, *L. exusta*, *L. bancrofti*, and *L. anatina*: Johnston and Hirschfeld, 1920, are synonyms of *L. rostrum*. *Lingula tumidula*: Johnston and Hirschfeld, 1920, is a synonym of *L. adamsi*. The true *L. tumidula* has not been rediscovered in its type locality (Moreton Bay) or in the Queensland Museum collection.

The taxonomy of all species of *Lingula* needs revision, for, as with the species discussed above, confusion has been created owing to the previous lack of taxonomic characters that could be used to establish species identity.

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PLATE 1

a-d: *Lingula anatina*. a, dorsal view of a complete animal; b, side view;  
c, interior view of a dorsal valve showing the median ridge (arrow);  
d, dorsal view of a shell of a Singapore specimen.  
e, f: *Lingula rostrum*. e, ventral view of shell; f, side view.

Scale lines = 1 cm.



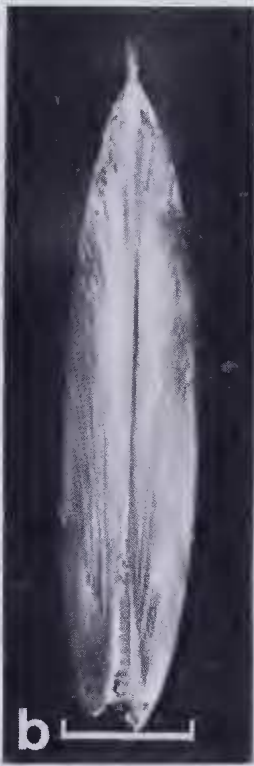


PLATE 2

a-d: Shell characters of *Lingula adamsi*. a, ventral and dorsal valve; b, ventral side of body showing the muscle arrangement and the mantle canals; c, two complete young specimens in dorsal view; d, specimen from the British Museum (B12561) figured by Davidson (1888, pl. 28, fig. 19) (by courtesy of Dr H. Brunton, British Museum). Scale lines = 1 cm.

e: Deltidial region, *Lingula adamsi*, interior view.

